WHAT IS CLAIMED IS:

1. A vortex reactor, comprising:

a substantially frustum-shaped portion forming a reaction chamber therein, said frustum-shaped portion having a narrower part that is downwardly oriented;

an axial flow apparatus fluidly connected to the reaction chamber for creating an axial gas flow in said reaction chamber;

a circumferential flow apparatus fluidly connected to the reaction chamber for creating a circumferential gas flow in said reaction chamber; and

a solid particulate inlet connected to said reaction chamber.

2. The vortex reactor of claim 1, wherein said axial flow apparatus comprises a gas supply and an apparatus selected from the group consisting of a porous bed and a flow restrictor.

3. The vortex reactor of claim 2, wherein said flow restrictor further comprises at least one channel therein which provides a fluid connection between said gas supply and said reaction chamber.

4. The vortex reactor of claim 3, wherein said circumferential flow apparatus is located below said flow restrictor.

5. The vortex reactor of claim 4, wherein a cross-sectional area of said at least one channel tapers from a first, cross-sectional area at an end of the channel that is fluidly connected to said gas supply, to a smaller, second, cross-sectional area at an end of the channel that is fluidly connected to the reaction chamber.

6. The vortex reactor of claim 1, wherein said apparatus for creating circumferential gas flow comprises a gas supply and one or more gas inlet nozzles oriented tangentially relative to a sidewall of the narrower part of said frustum-shaped portion.

7. The vortex reactor of claim 1, wherein said reactor further comprises a bottom entry tube fluidly connected to said reaction chamber at the narrower part of said frustum-shaped portion, and said apparatus for creating circumferential gas flow comprises a gas supply and one or more gas inlet nozzles oriented tangentially relative to a sidewall of the bottom entry tube.

8. The vortex reactor of claim 2, further comprising apparatus for generating plasma.

9. The vortex reactor of claim 8, comprising a flow restrictor which functions as a first electrode for plasma generation, wherein a sidewall of said frustum-shaped portion functions as a second electrode for plasma generation, and wherein said apparatus for generating plasma comprises an apparatus for applying a first voltage to said first electrode and an apparatus for applying a second, different voltage to said second electrode.

10. The vortex reactor of claim 9, wherein said flow restrictor is positioned to provide a small gap between said first and second electrodes for initiation of a plasma generating electrical arc at said small gap, and said flow restrictor is shaped to provide a gradual increase in the size of said gap between said first and second electrodes in an upward direction to provide a gliding arc in said reaction chamber.

11. A vortex reactor as claimed in claim 10, further comprising at least one flow restrictor located in an upper central portion of said reaction chamber for the purpose of impeding downward flow of gas in a central portion of said reaction chamber.

12. A method for fluidization treatment of solid particles, comprising the steps of

providing a vortex reactor, said vortex reactor comprising:

a substantially frustum-shaped portion forming a reaction chamber therein, said frustum-shaped portion having a narrower part that is downwardly oriented, and an upper portion,

an axial flow apparatus fluidly connected to the reaction chamber for creating an axial gas flow in said reaction chamber,

a circumferential flow apparatus fluidly connected to the reaction chamber for creating a circumferential gas flow in said reaction chamber, and

a particulate solids inlet connected to said reaction chamber;

introducing solid particles into said reaction chamber;

subjecting said solid particles to a vortex gas flow created by a combination of a circumferential gas flow and an axial gas flow; and

processing said solid particles.

13. The method of claim 12, wherein said axial gas flow is created by the steps of feeding gas in an axial direction into said reaction chamber and accelerating said axial gas flow through a flow restriction.

14. The method of claim 13, wherein said circumferential gas flow is created by the step of feeding gas into said reaction chamber in a direction tangential to a sidewall of said reaction chamber.

15. The method of claim 13, wherein said vortex reactor further comprises a bottom entry tube, said flow restriction is located in said bottom entry tube and said circumferential gas flow is created by the step of feeding gas into said bottom entry tube in a direction tangential to a sidewall of said bottom entry tube at a location below said flow restriction.

16. The method of claim 15, further comprising the step of generating plasma in said reaction chamber.

17. The method of claim 16, wherein the step of generating plasma in said reaction chamber comprises the step of providing a gliding electrical arc in said reaction chamber.

18. A vortex reactor, comprising:

a substantially cylindrical shaped portion forming a reaction chamber therein, wherein said substantially cylindrical shaped portion forms a first charged electrode;

a circumferential flow apparatus fluidly connected to the reaction chamber for creating a circumferential fluid flow;

a second charged electrode; and

an outlet for releasing said circumferential fluid flow.

19. The vortex reactor of claim 18, further comprising an axial flow apparatus fluidly connected to said reaction chamber for creating an axial fluid flow in said reaction chamber.

20. The vortex reactor of claim 19, wherein said axial flow apparatus comprises a gas supply and an apparatus selected from the group consisting of a porous bed and a flow restrictor.

21. The vortex reactor of claim 18, wherein said circumferential fluid flow apparatus is proximate to said outlet.

22. The vortex reactor of claim 18, wherein said outlet comprises a nozzle plate located at a first end of said cylindrical chamber.

23. The vortex reactor of claim 22, wherein said second charged electrode forms a portion of said nozzle plate.

24. The vortex reactor of claim 18, further comprising an axial flow apparatus fluidly connected to said reaction chamber for creating an axial or swirl fluid flow near an axis of said reaction chamber; and located at a second end of said cylindrical chamber.

25. The vortex reactor of claim 18, wherein an insulator is provided between said first charged electrode and said circumferential flow apparatus.

26. The vortex reactor of claim 18, wherein said apparatus for creating circumferential fluid flow comprises a gas supply and one or more gas inlet nozzles oriented tangentially relative to a sidewall of said cylindrical shaped portion.

27. The vortex reactor of claim 18, wherein said reactor further comprises an axial flow apparatus fluidly connected to said reaction chamber, and said apparatus for creating circumferential fluid flow comprises a fluid supply and one or more fluid inlet nozzles oriented tangentially relative to a sidewall of a bottom entry tube.

28. The vortex reactor of claim 18, further comprising an apparatus for generating plasma.

29. The vortex reactor of claim 18, wherein said circumferential flow apparatus generates an axially-symmetric circumferential fluid flow.

30. The vortex reactor of claim 18, wherein said circumferential flow apparatus further comprises an electrical insulator.

31. The vortex reactor of claim 18, wherein said second charged electrode forms part of said circumferential flow apparatus and an electrical arc is formed between said first charged electrode and said second charged electrode.

32. The vortex reactor of claim 18, wherein said second charged electrode is formed at different portion of said substantially cylindrical shaped portion than said first charged electrode and an electrical arc is formed between said first charged electrode and said second charged electrode.